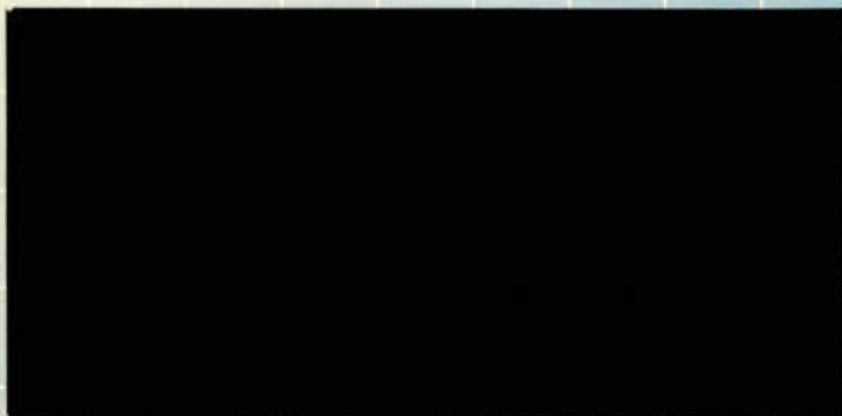




Economic Council
of Canada

Conseil économique
du Canada

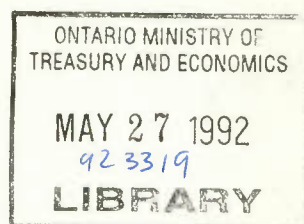


HC
111
.E34
n.30

c.1
tor mai

Working Paper Document de travail

Working Paper No. 30
**Tradable-Rights Approach to
Environmental Policy**
Some Accounting Problems of Application
Harry H. Postner



1992

ISSN 1180-3487

CAN.
EC 25-
30
1992

Tradable-Rights Approach to Environmental Policy

The findings of this paper are the sole responsibility of the author and, as such, have not been endorsed by the Economic Council of Canada.

The Economic Council's Working Papers are protected by the Crown copyright and may be reasonably quoted under the terms of Canada's copyright laws. Requests for permission to reproduce or quote long excerpts should be addressed to:

Director of Publications
Economic Council of Canada
P. O. Box 527
Ottawa, Ontario
K1P 5V6

Contents

Acknowledgments	vii
Foreword	ix
A Introduction	1
B Pollution Property Rights with Market Incentives	2
C Environmental Accounting Problems at the Firm Level	4
D Accounting for Tradable (Pollution) Rights as a Hedging Instrument	7
E A New Approach to National Environmental Accounting: Preliminary Proposal	10
F Conclusion: Future Research Agenda	14
Notes	17
Bibliography	19

Acknowledgments

This paper has benefited from encouraging and stimulating comments received from Caroline Pestieau of the Economic Council of Canada. Special thanks are also due to Kirk Hamilton of Statistics Canada and Philippe Crabbé of the University of Ottawa for very useful discussions and information. The paper has been revised in the light of remarks and queries originating from two referees.

Foreword

Tradable pollution rights have been intensively studied in the literature of environmental economics. But the problems of environmental policy application have not yet been analysed from an accounting point of view. The paper highlights three different aspects of accounting, both at the level of the business firm and the national economic level, that must be considered for a complete analysis. It turns out that the policy instrumentation of tradable pollution rights has (accounting) consequences far beyond those usually discussed in the economics and related literature.

The study was originally undertaken as part of a planned project on Canadian environmental policy. Harry Postner is a senior researcher with the Economic Council of Canada.

Judith Maxwell
Chairman

A Introduction

Economic activity ultimately involves the removal of materials and other elements from the environment, their transformation by production and consumption, and their eventual return to the environment. Resource economics is concerned with problems relating to the removal of material elements from the environment. On the other hand, environmental economics is concerned with problems related to the return of transformed materials to the environment. Environment deterioration occurs when the material returns, transformed into various types of pollution and other residuals, exceed the natural absorptive capacity of the environment.¹

This paper is an exercise in environmental economics. We are essentially interested in the problems of environmental deterioration and in the formulation of environmental policy to prevent such deterioration and restore appropriate environmental quality standards. Within this context, the paper mainly focuses on one particular environmental policy instrument – marketable (or tradable) pollution rights (or permits). This policy instrument is of special interest to Canadians since the conceptual idea behind marketable pollution rights was first analysed by the Canadian economic historian John Dales [1968a and 1968b]. Since its original conception, the idea has become widely known and subject to considerable empirical testing and theoretical refinement. The next section of this paper, section B, will offer a brief review of the extensive literature on the subject so that the paper could be reasonably self-contained. References are given for readers interested in further detail, particularly with respect to the question of market incentives.

The main thrust of the paper, however, can be found in the next three sections. The emphasis is on problems of environmental policy application with respect to marketable pollution permits (other instruments are also mentioned). But the problems dealt with in these sections are largely original and are *not* the ones to be found in the conventional literature. The three sections C, D, and E, all have one major theme in common: *an accounting point of view*. It will be seen that there are different aspects of accounting to be considered if a policy instrument analysis of, for example, marketable permits is to be complete.

Section C considers a range of (micro) accounting problems at the level of the firm. A new literature on this subject is just beginning to develop *via* the establishment of environmental accountability standards. But there are still many open questions. The problems in this section are also related to some considerations of public-sector environmental infrastructures that are now receiving increased attention. In section D we take a slightly different accounting approach and consider the “unique” connection between marketable pollution permits and their potential property as a sort of financial instrument

2 Tradable-Rights Approach to Environmental Policy

for risk diversification and hedging. Indeed, it is even possible to consider the establishment of markets for trading in pollution permit futures, options, and options on futures! And all this must be "correctly" accounted for. The next section E turns to recent activities in the field of (macro) national environmental accounting. It turns out that this field is currently isolated from the more micro-accounting problems considered in sections C and D. In fact, national environmental accounting is even largely isolated from most considerations of design of environmental policy instrumentation. We try to show that a new approach featuring some cross fertilizations is long overdue. This leads naturally to a conclusion in section F with emphasis on some directions for future research. The pervasive influence of John Dales is once again evident in the conclusion.

Finally, it might be noted that this paper is essentially non-technical in orientation. The reader, though, is assumed to have some general knowledge of environmental economics, but not necessarily any knowledge of the various aspects of environmental accounting. The treatment of the overall subject matter is somewhat brief and introductory; some of the requirements for a more complete treatment are outlined in the final section F.

B Pollution Property Rights with Market Incentives

This particular section does not contain any material that cannot be found in the available literature. We merely survey the economic concepts and theory behind the environmental policy instrument – marketable pollution permits. The general idea is to provide essential background to the innovative and original conceptions found in the remaining sections of the paper. Before continuing, it might be noted that marketable pollution permits are sometimes referred to as pollution property rights (with market incentives); the two conceptions are meant to be synonymous in this paper.

In effect, the simplest form of environmental policy instrument is the (non-transferable) pollution permit, the terms of which embody and regulate limitations on pollution discharge to the environment. It is well known in the theoretical literature that quantitative limitations *via* pollution permits per se are not a cost-efficient means of controlling environmental deterioration (see, for example, Baumol and Oates [1988]). But it is also possible to create a situation in which prices are attached to pollution discharge permits by a sort of decentralized, market-like process. In this case, pollution permits are allowed to be *tradable* among interested parties at commonly agreed market prices (assuming that the supply of permits is sufficiently constrained so that the total permit supply would be less than the total potential demand at zero prices).

So the limited quantity of pollution permits limited by a regulatory body is ultimately allocated through an artificial market process. If a business firm learns that it can abate pollution at a cost lower than the market price of the permits, then the firm will sell its pollution rights to another polluter, whose potential abatement costs are greater than the market price of permits. The sale and purchase of pollution rights will continue until the marginal costs of pollution abatement are equalized across all firms – and equal to the final market price of the pollution rights. The economic cost-efficiency of an environmental policy design based on the incentives offered by marketable pollution permits then follows (see, for further details, Bohm and Russell [1985] and Oates [1990] among others).

To further motivate our interest in this particular policy instrument, some additional points can be made. By specifying the total quantity (or supply) of tolerable pollution permits, environmental quality is presumably “guaranteed” (see also the discussion in section F). But a price is charged for using the environment as a pollution receptor, and the public regulatory officials need not worry about whether the price is “too high” or “too low” for the *particular* pollution permits involved. The regulatory body only has to set pollution quantity (or, equivalently, environmental quality) targets for different environmental systems. Once these targets are specified, the market process will eventually find the correct relative prices. In effect, trading will occur until a set of equilibrium prices for pollution rights is found such that demand equals supply for each type of pollution permit rights.

It should be recognized, though, that the above description overlooks many practical problems such as: initial distribution of pollution rights, delineation of environment regional systems, complementarity of demand, duration of pollution rights, monopolistic (and monopsonistic) market trading practices, and the existence of increasing (rather than decreasing) returns to scale in the firms’ pollution abatement cost schedules. There are also problems of specifying the conditions under which the “final” equilibrium allocation of pollution abatement costs (and pollution permits) corresponds with a generally accepted Polluter Pays Principle (PPP). These issues are well discussed in such references as: Hahn [1990], Pezzy [1988], Tietenberg [1985], and Dewees [1980].

Nevertheless, theoretically speaking, a competitive equilibrium in the pollution permits market is supposed to lead to an allocatively efficient outcome. The dynamics of the outcome are also favourable since with a generally rising price level and new additional sources of environmental pollution from economic growth, the market price of pollution permits will accommodatively rise to clear the market as a result of excess demand (assuming fixed supply of permits). As the price of pollution permits rise, it will be efficient for existing dischargers to further abate their pollution, thus making room

4 Tradable-Rights Approach to Environmental Policy

for newcomers. No additional regulatory measures are required to maintain environmental quality standards.

Finally, when pollution permits are *initially* distributed without charge to existing sources who are then free to trade permits among themselves or to sell to new sources (or even hoard the permits for future use), this is tantamount to the creation of a valuable *asset*. We will see, however, that the asset must be correctly accounted for. The existence of such an asset also has important implications.

C Environmental Accounting Problems at the Firm Level

The environmental problems dealt with in this paper presuppose that pollution sources originate with the industrial firm. The firm may be privately owned or publicly owned (i.e., a public corporation). In either case, it is assumed that the "firm" is subject to a set of business accounting standards. Therefore, we are not concerned in this paper with environmental policy instrumentation directed towards the household sector of the economy. The household sector typically does not possess formal accounting records and so is not subject to accounting rules or regulations. It might be possible, nevertheless, to apply, for example, marketable pollution permits at the household level. But the theoretical rationale of this instrument tends to break down because households' economic activities lie outside the formally recognized production boundary: there is no counterpart of the firms' pollution abatement cost schedules. However, some future research possibilities with respect to the household sector are mentioned in the paper's final section.

Business accounting standards regulate the rules by which income statements and balance sheets of the nation's major corporations are drawn up. In particular, the rules have a quasi-legislative effect on how financial reports to shareholders and the general public are prepared and how taxation reports to governments are compiled. So the economic behaviour of the large business and government firms is influenced by the accounting rules of the game. Any official regulatory policy designed to change the behaviour of these firms must, therefore, be formulated in the light of the accounting rules. But these accounting standards (or rules) are themselves subject to change, particularly if the related accounting issues are relatively new and not yet fixed. This, indeed, is the situation today with respect to accounting standards related to the environment. In Canada, business accounting standards are predominantly regulated by the Canadian Institute of Chartered Accountants (CICA). We will now show the relevance of these background considerations to the main themes of this paper.

In Canada and other industrial nations, accounting standards at the level of the firm with respect to environmental policy instruments are evidently still in a state of flux. Consider, again, the policy instrument discussed in section B, namely, "marketable pollution permits." The accounting questions posed in the following paragraphs are still open.

Should the business firm regard the purchase of marketable pollution permits as a current expense or as a capital asset investment subject to "depreciation" over the lifetime duration of the permit? (The choice could affect the firm's reported accounting costs and profits per unit of accounting time period.) If the pollution rights are initially distributed to existing firms without charge, should this distribution be accounted for as a current transfer or as a capital transfer? In the latter cases, tradable pollution rights become a capital asset of the firm. Does the market value of the permits offset the expected decrease in share values shown on accounting balance sheets that result from the imposition of pollution controls and the cost of the firm's pollution abatement program? How can all this be translated into the accounting language of "double-entry bookkeeping"? There are other questions too.

When these permits are sold or leased out by the firm, prior to expiration, should the net proceeds be regarded as an operating profit or as a realized capital gain?² Should these respective net proceeds be subject to tax in a differential way? If a firm's pollution permits are neither sold nor officially utilized (to permit pollution), but are rather "banked" or "hoarded" as, say, intangible capital assets, then how should we account for realizable capital gains (or losses) with respect to these assets? Clearly the choice of appropriate business accounting standards will influence business firm behaviour and, therefore, partly determine the cost-efficiency of the environmental policy instrument. But in all the literature analysing the potential efficiency properties of marketable pollution permits, there is very little substantive discussion of the environmental accounting standards at the level of the firm. And, based on our inquiries and knowledge, CICA has not yet formulated or proposed precise accounting standards with respect to these matters.

A reading of the applied literature on environmental policy instruments, particularly those featuring market incentives (e.g., Tietenberg [1990], Bohm and Russell [1985], Pezzy [1988] and Hahn [1989]), leads to the following implications. There appears to be considerable economic hesitation and uncertainty with respect to the implementation and real impact of these instruments. (The range of policy instruments includes "liability insurance schemes," "deposit-refund systems," and so-called "performance bonds" as well as "marketable pollution permits.") The present writer suspects that a large part of this hesitation and uncertainty could be removed once the business accounting rules of the game have been established and standardized. The new standards would need to encompass, for example, both intranational trading and

6 Tradable-Rights Approach to Environmental Policy

leasing in pollution permits and international trading. The stakes are potentially large and global. The new accounting rules would need to have sufficient depth in order to cover the many different *varieties* of particular environmental policy instruments such as marketable pollution permits. This is, however, what business accounting standards boards have been set up to do. Their corresponding institutions, such as CICA, are always open to informed analysis and recommendations from both impartial and vested-interested parties.

There is, however, another branch of environmental accounting at the firm level where some literature has developed and where some steps have been taken towards the establishment of accounting standards. This branch is not directly related to environmental policy instruments per se and so will be discussed rather briefly. The branch might more accurately be described as one of environmental accountability.

The general idea here is to extend the financial reporting statements of business (and public-sector) firms so as to have a more *explicit* disclosure of the firms' environmental abatement and control expenditures and environmental risk impacts. The expenditures are meant to cover both operating and capital costs (with an appropriate distinction) and to include both waste removal and site restoration costs. The environmental risk impacts involve the recording of actual and contingent liabilities for environmental damage and the setting up of financial provisions and catastrophe reserves. There are also suggested accounting disclosure requirements with respect to insurance against the consequences of environmental damage. In effect there is an accounting movement towards disclosing the environmental externalities of production and investment in addition to the standard economic transactions (an idea first proposed in Estes [1972]).

Discussion and analysis of the above issues from the accountability viewpoint are currently concentrated at the United Nations Centre on Transnational Corporations as seen in United Nations International Accounting and Reporting Issues [1991]. Canada has been represented at these deliberations by CICA and other Canadian accounting bodies. But the deliberations are still at an early stage. Precise accountability standards have not yet been formulated according to the most recent available reports.³

Trends described in the preceding paragraph have two major implications. An explicit disclosure of the firms' environmental expenditures on abatement and control will aid regulatory authorities in determining the cost-effectiveness of the various environmental policy instruments. For example, marketable pollution permits offer the highest gains in economic efficiency when there are large differentials between the firms' (marginal) abatement cost schedules. The disclosure of environmental risk impacts alerts the regulatory

officials to the need for new applications of policy instruments and the identification of new problem areas. The second major implication is simply that the appropriate extension of accountability reporting standards, as outlined above, will help furnish the raw data for the special environmental survey on pollution abatement and control expenditures that Statistics Canada is just beginning to perform (see Statistics Canada [1990a]).

Finally, it might be noted that Statistics Canada is also performing a pioneering survey of the Canadian waste management sector. The survey evidently covers both the private and public aspects of the sector (see Statistics Canada [1990b]). Public waste management activities in Canada are largely the responsibility of the municipalities and financially account for both operating costs and capital investment expenditures. The survey includes the waste collection, disposal (haulage and sewerage), incineration, treatment plants, and recycling activities of the municipalities. CICA has recently [1989] suggested some accounting definitions and standards with respect to expenditures and budgeting of public capital infrastructure that can be usefully exploited in this connection. We will be hearing much more in the future about investment in public environmental infrastructure and its appropriate treatment in capital budget accounts of the various Canadian public sectors. Hence the need for some synthesis of: public-sector accounting, economics, and statistics, when attempting to apply environmental policy.

D Accounting for Tradable (Pollution) Rights as a Hedging Instrument

The description of the tradable-rights approach to environmental policy, given in the previous section B, is incomplete. The purpose of this section, then, is to complete the discussion with emphasis on some unique economic characteristics of and opportunities provided by that policy instrument; characteristics and opportunities that are often overlooked. Once this is done, we could again turn to our particular interest in accounting problems of application, some of which are analogous to those of the "new financial instruments" as in OECD [1988] and [1991].

In section B it was essentially assumed that pollution rights (or permits) are initially distributed to existing sources of industrial pollution and are then tradable among these sources. There was no need to specify the particular distribution scheme (e.g., "grandfathering"). But it was mentioned that newly arriving industrial polluters would be capable of purchasing part of the original allocation of permits from existing pollution sources at the appropriate market price. There are, however, a number of additional features to tradable pollution rights that must be considered. These features have important consequences.

First, there is a key role to be played by purely arbitrage activities. Market-making entrepreneurs can engage in buying permits from one firm in order to sell to another firm when profitable (nonequilibrium) opportunities exist. Indeed, arbitrage entrepreneurs may even speculate on future price spreads – buying now to sell later, or selling now (in effect, borrowing now) in order to buy later at a lower price, and so on.

Second, it is perfectly possible for the tradable pollution rights scheme to embody a mechanism whereby (additional) pollution rights might be created or “earned” as a result of undertaking economic activities that actually reduce pollution levels *below* the quantitative targets set by regulatory bodies. (For example, reforestation reduces carbon levels in the atmosphere.) The economic activity would then be profitable if the market value of the “earned” permits exceeds the cost of the original project.

The third feature missing from our previous discussion involves innovation and the changing state of technology. The equilibrium market price of pollution permits reflects *inter alia* the pollution abatement cost schedules of the various polluting firms; these cost schedules depend on the technology used by the firms and their input-output mix. So the introduction of new industrial processes or new pollution abatement technologies will have profound effects on the demand (and even supply) for pollution permits and their corresponding market prices. The market for pollution rights should be analysed in a dynamic context and in the light of various risk elements involved.

Putting the three features together exposes some special properties inherent in the environmental policy instrument with which we are concerned. Note that the respective roles of “new technology makers” and “new permit creators” are somewhat analogous to those of the “entrepreneurial market makers.” Indeed, the true environmental entrepreneur might successfully combine all three roles. Also note that viewing marketable pollution permits in this dynamic and, in fact, speculative context serves to countervail claims in the literature (e.g., Dewees [1990]) that the active market for such permits might be too thin to obtain ultimate cost-effectiveness of the policy instrument.

With this background, we now arrive at the key argument of this section (see also Epstein and Gupta [1990]). Entrepreneurial activities that involve investment in new environmentally related technologies and innovations (e.g., reforestation, solar energy) also embody large elements of risk. Therefore, a hedging mechanism is desirable (i.e., a means for diversifying risk associated with the investment). The basic advantage of marketable pollution permits, say over other environmental policy instruments, is precisely the fact that such permits are themselves an instrument for diversifying risk and encouraging potential environmental-benefiting innovation. The prime reason for

this advantage is that the market price for pollution permits will be *negatively* correlated over time with the success of related new technologies that reduce or evade pollution.

The existence of an active and accessible market for pollution permits will encourage the risk averse to seek out and exploit new technologies that might benefit the environment. The investor in new environmental technology could diversify her portfolio by purchasing environmentally related pollution permits, thus hedging the risk of failure of the new technology while, at the same time, maintaining attractive expected rates of return. If the new technology proves to be economically successful in circumventing pollution, then the market price of the existing related pollution rights will fall; if the new technology fails, then the market price of related pollution rights will rise. So the investor can benefit from appropriate risk diversification – a standard result of the portfolio literature (e.g., Markowitz [1959]). We do not claim that marketable permits are the only possible source of hedging, but rather that the policy instrument is a tailor-made guaranteed hedging device that does not require the expenditure of extensive search resources in order to identify such a device.

So the liquidity and ease of entry and exit into markets for pollution rights encourage innovative investment in environmentally related technologies that, by themselves, are risky activities. Marketable pollution permits have a further advantage of “detachability.” The enterprise actually undertaking the development of new technology need not itself corporatively hedge the exposure to risk (as explained in a special case by Epstein and Gupta [1990]). Rather each set of investors (or stakeholders) in the enterprise can choose the degree of hedging to suit the investors’ own appetite for risk. But in all cases of at least some risk aversion, the appropriately related pollution-permit market will serve as the optimal source of hedging instrument, as well as an optimal choice of environmental policy instrument.

It should now be clear that the market for pollution permits contains many participants other than the original industrial firms receiving the initial allotment of permits. The limited property rights to pollute the environment are bought and sold (or even created) by parties outside the circle of industrial firms directly or indirectly responsible for the emission of pollution (and, therefore, outside the circle of firms that actually *expend* the pollution permits). This, in effect, means that the accounting problems discussed in the previous section are only part of the story, since their application is restricted to the original industrial firms. Moreover, the nature of the accounting problems previously discussed is also only partly relevant. We have discovered in the present section that tradable pollution rights are not only an environmental policy instrument, but are also a financial hedging instrument to entrepreneurial market-makers and to entrepreneurial investors in environmentally

related new technology. All this raises a corresponding new set of accounting problems which will be more evident as pollution permits become tradable on national commodity exchange markets (as in *The New York Times* [1991]). One might say that John Dales' original conception [1968a and b] is being carried to its logical conclusion!

If tradable permits are regarded, by market participants, as a financial hedging instrument, then their accountability and disclosure in the participants' financial reporting statements are problems directly analogous to those already discussed in the literature with respect to the so-called "new financial instruments." A good introduction to the scope of the discussion can be found in OECD [1988] and [1991]. It should be noted, however, that precise accounting standards with respect to these instruments have not yet been formulated. Similarly, there has been some discussion of the incorporation of the "new financial instruments" into the capital finance accounts and balance sheets of national economic accounts (see United Nations [1990c]). But again, definitional and classification matters have not yet been settled.

Finally, once it is recognized that tradable pollution rights can be deployed as a hedging instrument, then the path is open to further extensions. It is easy to imagine the establishment of markets for trading in pollution permit futures, options, and even options on futures. (See again *The New York Times* [1991]). The techniques of "calls," "puts," and various combinations of these with "futures" on the underlying prices of pollution permits, are all potentially applicable. There is already a rich economic literature on arbitrage relationships, option pricing formulae (e.g., the Black-Scholes formula), and the institutional particulars of related markets. What is missing today are appropriate accounting standards so that available financial statements would provide a "complete and fair view" of the financial position of the business parties involved.⁴

E A New Approach to National Environmental Accounting: Preliminary Proposal

The purpose of this section is to relate the developments outlined in the previous sections to some current activities in the new field of national environmental accounting. The latter field is far from settled and is not unlike the state of national economic accounting some 50 years ago. For the purposes of this paper we take national environmental accounting to mean the summation of research activities now directed towards incorporating or *integrating* natural environmental considerations with the economic and financial considerations that now characterize conventional national accounts.

It should be noted that conventional approaches to economic accounts already do embody some natural environmental factors (e.g., in the drawing up of national balance sheets and related reconciliation accounts). But the embodied scope is significantly limited. Also the utilization of the term "integrating," as above, does not necessarily imply a complete formal integration of environmental matters with economic transactions. Our understanding of national environmental accounting includes the preparation of environmental satellite accounts as reflected in the UN Manual on Satellite Accounts [1990a]. But we do not necessarily rule out the eventual implementation of a fully integrated accounting system as proposed in the forthcoming UN Handbook on Environmental Accounting [1990b].

The main argument put forth in this section is that some key issues or dilemmas [Norgaard 1989] related to the field of national environmental accounting could be clarified and, perhaps, resolved by adopting a new approach, namely, a policy-oriented approach, to the methodological discussions that now characterize the field. In particular, national environmental accounting seems evidently isolated from the rich literature relating to choice of environmental policy instruments and their implementation. This is evident from the lack of references to that literature in, for example, the official UN publications and official proceedings at the recent International Conference on Environmental Accounting held in Baden, Austria, May 1991. It is this writer's considered impression that the resolution of outstanding technical issues in the field of national *economic* accounting was aided by adopting a policy-oriented, indeed a Keynesian, point of view (see Carson [1975]). The same or a similar analogy may hold today with respect to resolution of issues within national *environmental* accounting. We will now proceed with preliminary proposals for a new approach to national environmental accounting.

There are presently available a large collection of physical measures of environmental statistics and corresponding indicators of environmental quality. A good survey of the subject from a Canadian viewpoint is provided by Victor [1989] who distinguishes between four main components of environmental indicators: global, continental, national, and local. Each component has a wide array of appropriate subcomponents. What is missing from all this is the possibility of analogy with the traditional economic indicators: there is no overall "state of the environment" indicator or set of indicators aggregating and summarizing environmental conditions as a whole. The Victor [1989] paper conjectures that this discrepancy might be due to the lack of a theory of the environment as a system: the understanding of environmental systems is evidently primitive compared to the theory of the functioning of economic systems that underlie the success of aggregate economic indicators. The aggregation of economic indicators into a "state of the economy" statistic, as seen in the national economic account's GDP (gross domestic product) and GDW (gross domestic wealth), is ultimately based on valuation weights stemming

from observed "market prices." There are also valuation assumptions and imputations when market prices are not available and considerable controversy about the "functioning" of the economy.

All this raises the question as to whether physical environmental quality indicators can also be aggregated to provide a summary statistic (or statistics) of the state of the environment. And if the aggregation weights have a monetary valuation dimension, then the path is open to a significant integration of national economic accounting and national environmental accounting. Although some work along these lines has been suggested (see, for example, United Nations [1990b] and Harrison [1989]), we will now outline an approach that has not yet been investigated and that appears to have some potential value. The approach builds upon the special economic properties of the environmental policy instrument "marketable pollution permits."

Suppose that the collection of environmental indicator components (say, those recommended by Victor [1989]) are each regulated by a comprehensive system of marketable pollution permits. (The feasibility of such a system will be examined shortly.) For every such application of these pollution permits there will be a set of equilibrium prices to establish the "property rights" for permitting various types of pollution. The equilibrium prices are attained by a sort of market arbitrage process mentioned in the previous sections B and D of this paper. Some further characteristics of the "market prices" are mentioned later in this section. The market prices for pollution permits then represent a valuation of property rights to, say, "make air and water dirty." However, for our purposes we would need a valuation of property rights to, say, "clean air and water" and to, say, "quiet surroundings" (the counterpart of "congestion" and "noise pollution"). These are, in fact, "amenity rights" first introduced by Mishan [1967]. Clearly the two systems of "rights," pollution rights and amenity rights, must be closely related since the fewer the rights that are granted to pollute and congest the environment, the cleaner and quieter the environment will be (a point made by Dales [1968b]).

In effect, "amenity rights" are the *dual* form⁵ of "pollution rights." So to every set of market equilibrium prices for pollution rights, there must be a corresponding dual (or shadow) set of prices for amenity rights. If we know or observe a comprehensive set of market prices for pollution rights, then we should also be able to estimate a comprehensive set of "shadow" prices for environmental amenity rights.⁶ The two sets of prices, one being the dual form of the other, are the economic substance of standard welfare economics as is evident from an exchange of ideas in the literature between Stone [1972] and Meade [1973]. The resulting equilibrium set of prices for amenity rights then yields the valuation coefficients (i.e., the weights) required to aggregate environmental quality indicators of the type discussed by Victor [1989] and

others. Note the analogy with the market prices used to value and aggregate economic indicators; these are market prices for economic "goods," *not* economic "bads." So, similarly, we would want valuation prices and weights for environmental "amenities," *not* environmental "disamenities." And these valuation prices are not necessarily "zero," even for environmental amenities in the public domain, so long as the dual set of pollution permit rights are tradable and sufficiently constrained in quantity to yield positive market prices.

The property-rights approach to valuation and aggregation of environmental amenities required to integrate national economic and environmental accounting has certain consequences and limitations. First, since the approach ultimately derives from the policy instrumentation of marketable pollution permits, this means that the approach is limited to environmental applications where pollution permits and their tradability are feasible (e.g., industrial pollution and other residual wastes). It may be difficult to apply this technique to household-sector sources of environmental damage and to cases where the quantity of pollution permits are, effectively, set equal to zero. Second, restrictions on the quantity of pollution permits are determined by public choice of appropriate regulatory bodies, and the observed market prices of such permits depend on the operation of the trading and arbitrage mechanisms. So the estimation of the dual form of valuation weights for environmental amenities is limited to how well the original public choice *cum* market mechanisms for pollution permits works in practice. There could be price-distorting problems of "market power," "asymmetric information," "non-additivity" and "uncertainty" with respect to public choice regulations and market transactions. These distortions will bias the dual set of valuation prices for environmental amenities. (See also the discussion in the next section.)

But all this should be regarded in an appropriate context. The observed market prices for economic goods and services do not always embody the "correct" efficiency properties and are themselves often subject to some form of public choice regulation. In any event, the observed (or sometimes imputed) market prices for economic goods and services and the correspondingly estimated valuation weights (or prices) for environmental goods and services should all be considered as determined *simultaneously*. The introduction of a set of environmental policy instruments with market incentives, then, has effects that permeate throughout the economic/environmental complex. And this is as it should be! After all, our ultimate goal is to determine whether the overall state of the economic/environmental complex is deteriorating or improving over time and by how much.

The preliminary proposals outlined in this section have the potential for resolving one of the major dilemmas currently facing the field of national environmental accounting (i.e., the value/aggregation dilemma [Norgaard 1989]). It should be clear, however, that much more work remains to be done

in order to successfully implement our suggested resolution of the dilemma. A possible future research agenda is outlined in the following section.

F Conclusion: Future Research Agenda

The theory and practice of the environmental policy instrument known as "marketable pollution permits" has been kicking around the economic literature for over 20 years. In addition, we have been continually reminded that there is no such thing (or, almost no such thing) as "free disposal." Therefore, can anything new be said on the subject?

It is the view of this paper that not only can something new be said on the subject, but also that the conventional treatments of the subject matter are seriously incomplete. The main reason for this evaluation of the present state-of-the-art is very simple: excessive specialization! Specialists in environmental economic policy have overlooked environmental accounting problems at the level of the firm (as in section C). They have virtually ignored, with one exception, the incentive property of hedging and risk diversification inherent in the policy instrumentation of marketable pollution rights (as in section D). Moreover, specialists in national environmental accounting do not seem to be aware of developments in the area of micro-environmental accountability. Nor do they build upon the opportunities presented by the special characteristics of environmental policy instruments (as in section E).

The general purpose of this paper, then, is to provide some "missing links." But providing "missing links" is not an end in itself. The ultimate goal of this paper is towards application of environmental policy: 1) improving the statistical information base, 2) clarifying the market incentive structures, and 3) implementation of aggregated environmental indicators, all of which would aid formulation of policy. The tasks actually accomplished by this paper, however, are very limited. It is evident that the exposition is strong on statement of problems and weak on statement of solutions. And our statement of problems are themselves highly simplified and seriously incomplete. What precisely are some of the problems that require further examination and a future agenda?

First, it should be clear that the three major accounting sections of the paper are each an introduction to the problems involved. Indeed, the subject matter of each section really requires a major paper of its own together with extensive consultation with relevant Canadian institutions such as the Canadian Institute of Chartered Accountants, Statistics Canada, and the Canadian Environmental Advisory Council. It is hoped, therefore, that the paper would stimulate a more intensive investigation of the (accounting) problems introduced here.

Second, there is a range of implied assumptions made throughout the paper (and, in fact, in most of the environmental economic literature) that deserves to be relaxed. One or two of the assumptions have already been mentioned in passing. For example, marketable pollution permits and their accounting problems are largely restricted to the business sector and, partly, to the government sector of the economy. Is there an analogous policy instrument applicable to the household-sector sources of environmental deterioration? A suitably modified "deposit-refund system" with tradable refund rights may be such an instrument, but the subject requires investigation (see, for example, Bohm [1982]). A case may also be made for tradable "vouchers" (after their initial distribution to householders) and tradable rights to "separate facilities" to overcome environmental problems of congestion (as argued by Mishan [1967]). Leasing rights and franchise rights are already tradable. It would be important to have such an extension of the analysis so that the overall system of marketable pollution rights, as utilized in section E of this paper, would be truly "comprehensive" (i.e., a mutually exclusive and exhaustive system of coverage).

There is, however, another set of "hidden" assumptions that must be exposed. The economic-theoretical apparatus underlying marketable pollution rights and their economic accounting counterparts have two built-in suppositions: 1) strictly linear (or additive) environmental impacts with respect to each pollutant and 2) non-interacting and separable environmental impacts between different pollutants.⁷ It is also implicitly assumed that environmental impacts are smoothly continuous and not subject to discrete "jumps" and severe "thresholds."⁸

Herein lies the conventional world of economics and its assumptions. But this is *not* the natural environmental world of chemistry and ecology. The relaxation of these "hidden assumptions" would extremely complicate the problem of identifying valuation aggregated indicators of environmental amenities as proposed in the previous section E. In effect, the valuation weights would no longer guarantee the cost-efficiency and decentralized market incentive-compatibility properties originally described in sections B and D and implicitly utilized in section E of this paper. Even the existence of nationally organized commodity exchange markets for pollution permits would not resolve the "aggregation" problem in an optimal manner.

It is very difficult at the present time for economics and accounting (and their corresponding institutions) to simulate chemical and ecological impacts and interactions stemming from multiple sources of different pollutants. Nor will this research task be attempted here. The proposals contained in this paper could be regarded as a first approximation towards the real world of environmental complexity. There is no reason, however, why economists should be excessively modest about their proposals so long as the limitations are

recognized and opportunities for future progress are not neglected. Consider, for example, the following quotation from a leading ecologist, Kay [1991] at a recent symposium organized by the Canadian Environmental Advisory Council (CEAC):

The subject of this paper is indicators of ecological sustainability . . . an appreciation of the state of ecology is required. Ecology as a science is at a formative stage, in much the same state as physics at the time of Galileo. We await the insight of a Newton. There is little consensus in theoretical ecology about what the important characteristics of ecosystems are.

It would appear, then, that the two fields of economics and ecology could benefit from mutual research cooperation. Some concrete recommendations along these lines were, in fact, made at the recent CEAC symposium. All this is very much in the spirit of John Dales' original conception some 25 years ago and the ultimate inspiration of the present paper.⁹

Notes

- 1 The two descriptions with regard to "resource economics" and "environmental economics" should be understood as brief introductory statements to the concerns of this paper.
- 2 This is not an academic question, but a problem that turned up very recently with respect to accounting rules imposed on public utilities that ban them from seeking a capital gain on their investments; see *The Economist* [1992].
- 3 The subject matter is sometimes discussed in the accounting literature under the name "corporate social accounting," examples of which can be found in Ross [1985] and Estes [1986].
- 4 A good introduction to the business accounting issues with respect to portfolio investments, options, futures and swaps can be found in Skinner [1987, Chapter 16].
- 5 A reviewer of this paper has remarked that the use of the "duality" notion could be misleading; a more adequate notion might be "complementarity." So some readers might prefer to think in terms of complementarity between "amenity rights" and "pollution rights" rather than their duality.
- 6 In a perfect market equilibrium, the two sets of prices (pollution rights and amenity rights prices) would be the same, assuming that the implicit objective functions for the two institutional set-ups are identical.
- 7 These suppositions are also exposed in Bohm and Russell [1985], using a relatively simple framework.
- 8 A reviewer has also pointed out the problem of the "dynamics of aggregate cumulative impact" and the associated limits of strictly static methods with respect to environmental concerns.
- 9 One should note, in this respect, the existence of the *Journal of the International Society for Ecological Economics*.

Bibliography

- Baumol, W. J., and W. E. Oates [1988]. *The Theory of Environmental Policy*, second edition. New York: Cambridge University.
- Black, F., and M. Scholes [1973]. "The pricing of options and corporate liabilities." *Journal of Political Economy* (May).
- Bohm, P. [1982]. *Deposit Refund Systems: Theory and Applications to Environmental Policy*. Resources for the Future, Washington.
- Bohm, P., and C. S. Russell [1985]. "Comparative analysis of alternative policy instruments." In *Handbook of Natural Resource and Energy Economics*, eds. A. V. Kneese, et al., vol. I, Chapter 10. Amsterdam: North Holland.
- Canadian Institute of Chartered Accountants [1989]. *Accounting and Reporting for Physical Assets by Governments*. A Research Study, Toronto.
- Carson, C. S. [1975]. "The history of the United States National Income and Product Accounts: the development of an analytical tool." *The Review of Income and Wealth* (June).
- Dales, J. H. [1968a]. "Land, water, and ownership." *The Canadian Journal of Economics* (November).
- _____. [1968b]. *Pollution, Property and Prices: An Essay on Policy-Making and Economics*. Toronto: University of Toronto Press.
- Deweese, D. N. [1980]. "Evaluation of policies for regulating environmental pollution." Regulation Reference, Working Paper no. 4, Economic Council of Canada, Ottawa, September.
- _____. [1990]. "The regulation of sulphur dioxide in Ontario." In *Getting It Green: Case Studies in Canadian Environmental Regulation*, ed. G. B. Doern. Policy Study 12, Chapter 6. C. D. Howe Institute.
- Epstein, J. M., and R. Gupta [1990]. *Controlling the Greenhouse Effect: Five Global Regimes Compared*. Brookings Occasional Papers, The Brookings Institution, Washington.
- Estes, R. W. [1972]. "Socio-economic accounting and external diseconomies." *The Accounting Review* (April).
- _____. [1986]. *Corporate Social Accounting*. New York: John Wiley and Sons.
- Hahn, R. W. [1989]. "Economic prescriptions for environmental problems: how the patient followed the doctor's orders." *The Journal of Economic Perspectives* (Spring).

- _____. [1990]. *A Primer on Environmental Policy Design*. New York: Harwood Academic Publishers.
- Harrison, A. [1989]. "Environmental issues and the SNA." *The Review of Income and Wealth* (December).
- Kay, J. K. [1991]. "The concept of ecological integrity, alternative theories of ecology, and implications for decision-support indicators." In *Economic, Ecological and Decision Theories*, P. A. Victor, et al. Canadian Environmental Advisory Council, Ottawa.
- Markowitz, H. M. [1959]. *Portfolio Selection: Efficient Diversification of Investments*. New York: Wiley Publications.
- Meade, J. E. [1973]. "Citizens' demands for a clean environment." *L'industria*, no. 3/4.
- Mishan, E. J. [1967]. *The Costs of Economic Growth*. London: Staples Press.
- Norgaard, R. B. [1989]. "Three dilemmas of environmental accounting." *Ecological Economics*, no. 1.
- Oates, W. E. [1990]. "Economics, economists, and environmental policy." Unpublished paper, University of Maryland.
- Organisation for Economic Co-operation and Development [1988]. *New Financial Instruments: Disclosure and Accounting*. Paris: OECD.
- _____. [1991]. *New Financial Instruments*. Accounting Standards Harmonization, no. 6. Paris: OECD.
- Pezzy, J. [1988]. "Market mechanisms of pollution control: polluter pays, economic and practical aspects." In *Sustainable Environmental Management: Principles and Practice*, ed. R. K. Turner, Chapter 9. London: Belhaven Press.
- Ross, J. A. [1985]. "Accounting for hazardous waste." *Journal of Accountancy* (March).
- Skinner, R. M. [1987]. *Accounting Standards in Evolution*. Holt, Rinehart and Winston of Canada Ltd.
- Statistics Canada [1990a]. "Survey outline: pollution abatement and control expenditures." Unpublished document, Ottawa, June.
- _____. [1990b]. "Survey outline: the waste management sector." Unpublished document, Ottawa, June.

Stone, R. [1972]. "The evolution of pollution: balancing gains and losses." *Minerva* 10, no. 3.

The Economist [1992]. "Pollution control: unshackling the invisible hand." 4 January, p. 66.

The New York Times [1991]. "Commodity exchange plans trading in pollution permits." Wednesday, 17 July.

Tietenberg, T. H. [1985]. *Emission Trading: An Exercise in Reforming Pollution Policy*. Resources for the Future, Washington.

_____. [1990]. "Economic instruments for environmental regulation." *Oxford Review of Economic Policy* (Spring).

United Nations [1990a]. "Satellite accounts." Draft chapter of revised SNA, UN Statistical Office, New York.

_____. [1990b]. *Towards Integrated Environmental and Economic Accounting*. Chapter 1 of the Draft SNA Handbook, UN Statistical Office, New York.

_____. [1990c]. "System of National Accounts (SNA) review issues." UN Statistical Office, New York, February.

_____. [1991]. *International Accounting and Reporting Issues: 1990 Review*. UN Centre on Transnational Corporations, New York.

Victor, P. [1989]. "Indicators and indices of the state of the environment." Report submitted to Statistics Canada, October.

HC/111/.E34/n.30

Postner, Harry H

Tradable-rights

approach to

ekfd

c.1

tor mai

JUN 2 6 1992

JUL 1 5 1992

AUG 2 5 1992